FOR OFFICIAL USE.

REPORTS

TO THE

LOCAL GOVERNMENT BOARD

ON

PUBLIC HEALTH AND MEDICAL MATTERS.

(NEW SERIES NO. 79.)

Dr. S. W. Wheaton's Report to the Local Government Board on Enteric Fever at Strood in Rochester Borough, in 1912.

LONDON:
PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE.
To be purchased, either directly or through any Bookseller, from
WYMAN AND SONS, LIMITED, FETTER LANE, E.C., and
54, ST. MARY STREET, CARDIFF; or
H.M. STATIONERY OFFICE (SCOTTISH BRANCH),
23, FORTH STREET, EDINBURGH; or
E. PONSONBY, LIMITED, 116, GRAFTON STREET, DUBLIN;
or from the Agencies in the British Colonies and Dependencies,
the United States of America, the Continent of Europe and Abroad of
T. FISHER UNWIN, LONDON, W.C.

PRINTED BY
DARLING AND SON, LTD., BACON STREET, E.
1913.

Price Fourpence.

Dr. S. W. Wheaton's Report to the Local Government Board on Enteric Fever at Strood, in Rochester Borough, in 1912.

ARTHUR NEWSHOLME,
Medical Officer,
7th March, 1913.

On August 8th, 1912, the Medical Officer of Health of the Borough of Rochester reported the occurrence of 16 cases of enteric fever to the Board.

He stated that the first was notified on August 2nd, and all were on the north side of the river Medway. He also stated that there had been practically no enteric fever in the locality for some time previously, that there was no suspicion attached to milk or other food as a source of infection, and that he was reluctantly driven to the opinion that the water supply was the vehicle through which the fever was spreading. I was accordingly instructed to visit the borough and to make inquiry as to the outbreak, and this I did on August 12th and several subsequent occasions.

The Borough of Rochester is situate in the County of Kent, on the estuary of the Medway, about ten miles above the point where this river joins the Thames. On the south bank of the river is the ancient city of Rochester, on the north bank the modern town of Strood along with a portion of the increasing village of Frindsbury which is included in the borough.

The borough, which has an area of 2,936 acres, had in 1911 a population of 31,384 persons, of which not quite a half, *i.e.*, 13,428 lived in Strood. The greater part of the borough is situate on alluvium, consisting of silt, sand, loam, or gravel, but the higher levels, including the village of Frindsbury, rest upon the uncovered chalk. The land on each side slopes towards the river.

The people find employment in His Majesty's Dockyard, at cement works, brickfields, engineering works, and in connection with shipping, fishing, or the ordinary occupations of a semi-industrial town.

(1.) SANITARY CIRCUMSTANCES.

Water Supply.—This is derived from two separate sources, the Medway dividing one area of supply from the other. Rochester is supplied by a private water company, the Brompton, Chatham, Gillingham and Rochester Waterworks Company, which obtained an Act of Parliament in 1860.

No. 79.

(27832—21.) Wt. 34596—560. 500. 3/13. D & S.

Strood is supplied from waterworks which were purchased by the town council from the Strood Water Company in 1881. Both supplies are from the chalk by means of wells and adits, but the Rochester supply is supplemented by water from a boring which draws water from the lower greensand. The Rochester Waterworks are situate in the Luton valley to the east of Rochester, and also in the Capstone valley still further eastward. The Strood Waterworks are situate to the west of this place just on the borough boundary.

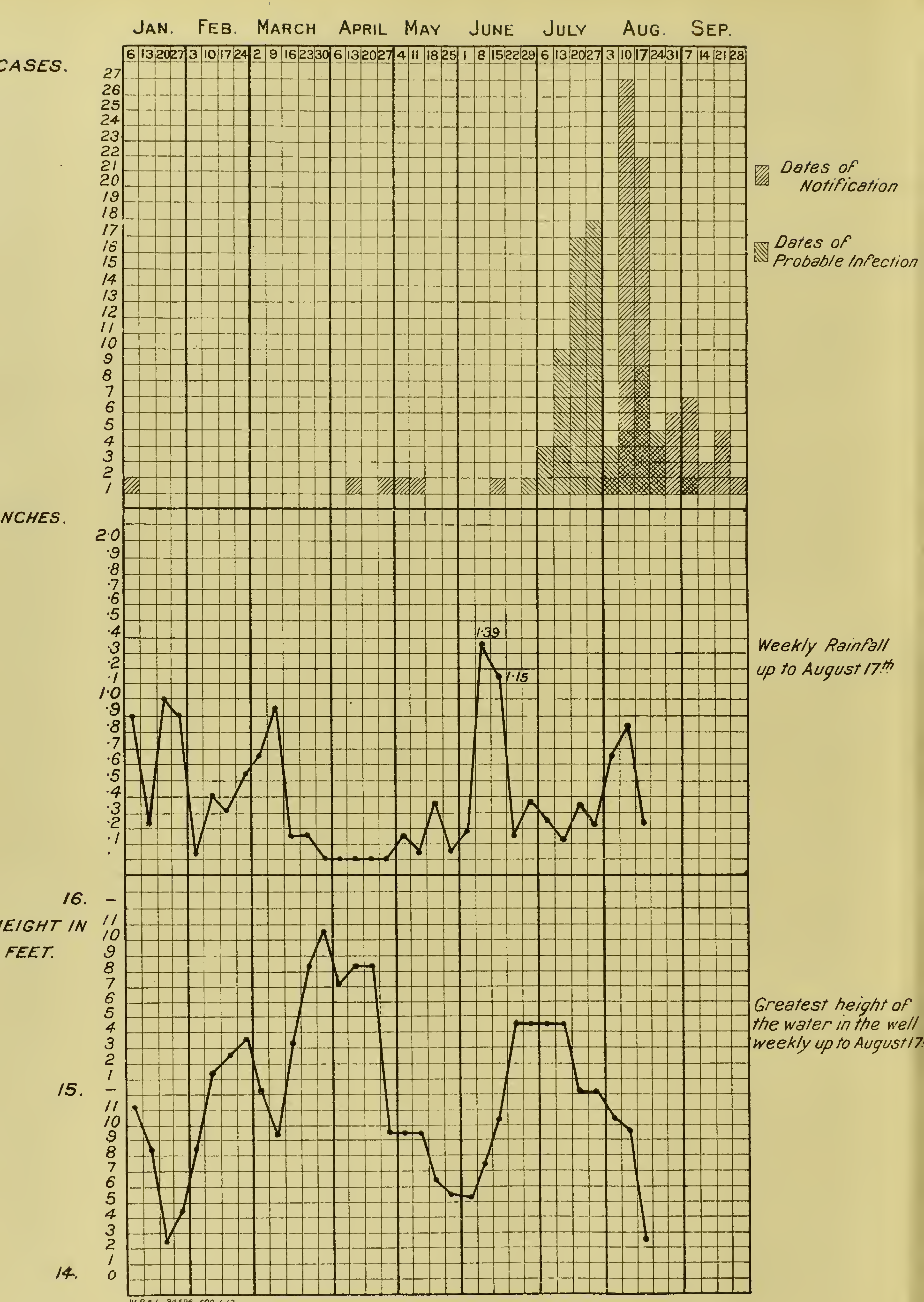
Sewerage.—There is no systematic sewerage in the borough. At Rochester and Strood there are a certain number of drains which convey the water from the highways to the river, and to which a certain number of cesspools as well as house drains are connected. In some instances also cesspit privies are connected to these drains.

Excrement Disposal is chiefly by means of water-closets, which are connected to cesspools, the contents of which soak away into the subsoil. There are also 800 privies, mostly of the kind known as "cesspit," some of these also receive liquid refuse thrown down them, and in most instances their liquid contents soak away into the subsoil. Water-closets are usually provided with separate flushing cisterns. From time to time cesspools become "clogged" with solid matter deposited on their walls. When this is the case the solid matter is scraped away by the scavenging staff of the town council so as again to allow of the ready escape of their contents into the surrounding soil; this process is termed sludging. In a large part of the borough, especially on the higher levels, the cesspools are constructed in the chalk, into the fissures of which the liquids escape; elsewhere they are in alluvial sand, loam, or gravel, overlying the chalk, into which their contents ultimately penetrate.

From time to time the Board have urged the town council to provide sewers for the borough, and have suggested combination with the adjoining Borough of Chatham for this purpose.

Refuse Collection and Disposal.—Refuse is placed in movable receptacles; these the householders place in the streets for collection by the council's staff. This collection is made daily in the main streets, on alternate days elsewhere. The receptacles are often unsatisfactory, old boxes, tubs, or uncovered pails, being used for the purpose.

The refuse is removed to tips, one at Rochester and one at Strood. There have been complaints of the tip at Strood. It is situate in an open space not far from the river bank, where the refuse, after screening, is in part used for brick-making. The remainder accumulates and when thoroughly decomposed is removed by farmers for use on the land. The tip is some considerable distance from any dwelling, but the complaints have referred both to effluvium and to flies which are said to be bred in the refuse. At the time of my visits, which were in cold or windy weather, no nuisance from either cause was observed, but it is quite likely that in hot still weather nuisance of this sort does arise.



W.B.&L.34596..500.1/13

House Drainage.—This is often found to be defective, the drains having been carelessly laid in loose soil without concrete support, consequently the pipes have become displaced with subsequent escape of their contents into the subsoil.

(2.) ENTERIC FEVER IN ROCHESTER BOROUGH.

The table below shows year by year the number of cases of enteric fever notified in the borough together with the number of deaths from this disease for the ten years previous to 1912:—

—	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.
Cases	36	46	39	34	34	32	59	19	16	13
Deaths	3	6	8	6	5	7	3	3	1	1

From this it will be seen that the disease has been always present year by year in considerable amount, but that for the last three years there has been a decided fall both in attacks and deaths. The average attack rate for the ten years is 1·0 per 1,000 of the population in 1911, as compared with rates of ·38 and ·35 for England and Wales and the County of Kent respectively in 1911. The above figures refer to the whole of the borough. In 1912, as will be seen later on, the outbreak of fever was practically limited to Strood and the diagram appended therefore relates to Strood only.

The diagram shows week by week during 1912 up to September 28th the number of notified cases of enteric fever in Strood in black hatching slanting downwards to the left, together with the date on which the cases comprised in the outbreak under notice, with three exceptions, were in all probability infected in hatching slanting downwards to the right; also the rainfall and the height of water in the well at the Strood Waterworks for the period ending August 17th 1912.

From the diagram it will be seen that during 1912 there were only six attacks notified until the week ending August 3rd, when the first case of the outbreak was notified on August 2nd. In the following week, that ending August 10th, however, 26 cases were notified, and in the next week 21. In the following week the notifications were three only, and thence during the next five weeks were five, six, two, four, and one respectively. The date of onset of illness could be obtained, with three exceptions, and by deducting 14 days from this for the period of incubation the probable date of infection was obtained. The results are shown on the diagram in hatching slanting downwards to the right. It will be seen that the first case of the outbreak was infected in the week ending June 29th; that persons continued to be infected week by week during four weeks ending July 27th, that after this week there was a very marked diminution of the number infected for one week, and then a slight rise during the three weeks ending August 24th. After this date only one case became infected during a period of five following weeks. The cause of the outbreak, therefore, practically ceased operation in the week ending August 24th, but notifications and illness from fever produced by it lasted some time later. Of the total of 69 cases, 33 were males and 36 females; 29 were under, and 40 over 15 years of age. Up to the 28th of September eight cases had terminated fatally. Nearly all persons attacked belonged to the working classes. During the period covered by the outbreak only two cases were notified in Rochester. These are not included in the diagram. One of these worked in Strood all day and drank water there. A man also died from enteric fever at Southampton after leaving Strood, under circumstances which made it practically certain that he became infected in Strood.*

CAUSATION OF THE ENTERIC FEVER OUTBREAK.

When I visited the district on August 12th I found that in the previous ten days 30 cases of fever had been notified, all of which were in Strood, and that during this period no cases had been reported in Rochester. The outbreak, therefore, appeared to be due to some cause the operation of which was limited to the Strood portion of the borough. The sufferers were found to be served by eight different milk supplies, some of which were also distributed in Rochester; quite half the persons suffering from fever had condensed milk only, so that it seemed very improbable that milk was the medium of infection. There was no suspicion attaching to any particular food. Shellfish are consumed to a small extent in the borough, but in two instances only had shellfish been taken by sufferers from fever within a period compatible with infection from such a source. For several years notices have been posted on the foreshore of the Medway warning people against collecting oysters or other shellfish. These notices are said to have been successful in obtaining the desired result. Attention was therefore directed to the water supply as the possible source of infection, especially since the supplies of Strood and Rochester are from entirely different sources.

On marking the position of the invaded houses on a spot map of the district it was found that they could not well have been more scattered all over Strood than they were, nor could the fever well have been more widely distributed in that area. The fever was limited to houses supplied by the Strood Waterworks. There were at that time no secondary cases in houses. All these facts strongly supported the thesis of the water supply being the medium of infection.

The water of the Strood Waterworks is distributed in a high and a low level supply. The fever was equally widely spread in the areas supplied from the high and low-level supply, although these two sets of mains are not in communication and the population supplied by these two sets of mains is nearly equal. Any local contamination of the water in the mains, as for instance, by the insuction of filth from defective arrangements for the flushing of water-closets, or from defective ball hydrants, could therefore be excluded as an explanation of the outbreak. It was evident that on the theory of causation by water the infective material must have been present in the water at its source, *i.e.*, in the water of the waterworks well.

---

* With one exception all the cases were confirmed by a positive Widal reaction.

Nothing occurred in the subsequent course of the outbreak which was inconsistent with this theory of water causation, indeed the further progress of the outbreak tended rather to confirm it. No cases which could be attributed to secondary infection occurred until quite late in the outbreak, the first being notified on August 29th and one on September 4th. Subsequently, up to September 28th only one other secondary case occurred and this was notified on September 13th.*

Circumstances of the Strood Waterworks.—The waterworks at Strood are situate on the London road at a distance of 1,000 yards from the Medway, but only 600 yards from an inlet of the river known as Janes Creek. They are just on the confines of a thickly populated district, which extends to the north of them, and also on the east between them and the river. To the south of the plot of ground on which the works are situate are a few scattered houses and to the west allotment grounds. The water is pumped from a well to a reservoir from which about half of Strood is supplied. This forms the low-level service. From this reservoir water is pumped to a high-level reservoir, from which the higher levels are supplied, including Frindsbury, forming the high-level service. The floor of the engine house, which is placed over the well, is 110 feet above ordnance datum, and the bottom of the adit from which the water is pumped is 114 feet below this. The water level in the adit is 3·4 feet below ordnance datum, and the lowest level of the adit is 10 feet below ordnance datum. The river bed is 15 feet below, the highest tide is 12 feet above, and the lowest 15 feet below ordnance datum.

Nearly the whole of the water is obtained from an adit which has been formed by following up and enlarging a large fissure in the chalk. This fissure runs from east to west for an unknown distance, and probably extends beneath the allotment grounds, 14 acres in extent and belonging to the corporation, which adjoin the waterworks site on the west. This fissure has been opened up for a length of over 115 feet, and the water enters it from subsidiary fissures, which cross it more or less at right angles, and also directly from the west. When the fissure was first opened up it was found to be filled in with sand. In the vicinity of the waterworks the chalk through which the well is sunk reaches the surface and is uncovered by any superficial deposits. These conditions obtain to the north, north-west, and west of the well, as also to the south of it. To the north-east, east, and south at a varying distance from the well the chalk begins to be covered by layers of superficial deposits. In the neighbourhood of the well are several old chalk pits, some of which have been filled in and built upon. About 100 yards to the north of the well is an open chalk pit in which fissures can be seen running vertically through the chalk from north-west to south-east so that their continuations would cross the main adit. These fissures are filled in with loose yellow sand and are from four to nine inches in thickness. Similar and probably identical fissures can be seen in a chalk pit about 200 yards south of the well. It is evident that these fissures are such that if they were exposed on the floor of a cesspool or crossed by a leaking drain or sewer they might convey filth directly into the water-bearing stratum of the chalk. Since there is every indication that these are the identical fissures which are known to open into the main adit from which the water is obtained and to cut it more or less at right angles, there is great probability that any filth entering them in the vicinity of the waterworks might be conveyed directly into the water of the adit.

---

* Up to the 30th of October three more secondary cases have occurred; one of these was nursing an unrecognised, and therefore unnotified case.

In the neighbourhood of the well are numerous cesspools connected with water-closets, the walls of which are formed by the bare chalk and the contents of which soak away into the chalk. There are also drains which are known to be defective. In the immediate neighbourhood of the well are four cesspools which have been made watertight by the town council and which are said to be the only ones in Strood which are in this condition. One of these is on the waterworks site. The position and connections of these cesspools with drains will be more particularly referred to later on. In the vicinity of the waterworks within a radius of 300 yards there would be at least 50 cesspools the liquid contents of which soak away into the chalk.

For some time past the results of both chemical and bacteriological analysis of the Strood water have been unsatisfactory. They have shown from the chemical point of view great variability in the quantities of the chemical components from time to time, pointing to the addition of extraneous matters.

The analyses have shown an increasing amount of chlorides, albuminoid ammonia, and nitrates. On bacteriological examination the bacillus coli has on occasion been found to be present in so small a quantity as 10 cubic centimeters of the water.

These observations in the case of a deep well water from a uniform formation, such as the chalk, show that there is pollution from organic matter, and there can be little doubt that in this case it is derived from the cesspools and defective drains allowing their contents to escape into the chalk, and possibly from other sources. Specimens of the water entering the main adit from several branches or fissures opening into it have been examined and found to vary in composition. Some have furnished evidence of pollution, but the water from the western extremity of the main adit has always proved of better quality than from the other sources. If to this condition of chronic pollution of the water there was added during the month of July, 1912, specific polluting matter derived from a case or cases of enteric fever the main epidemiological facts of the outbreak would be readily explained.

On July 22nd a specimen of the water from the rising main, *i.e.*, coming directly from the well, was submitted to Dr. Spitta of St. George's Hospital, who reported that the bacillus coli was present in 10 cubic centimeters but not in less. A specimen taken on August 8th showed, on examination at the Kent County Council's Laboratory, bacillus coli in 10 cubic centimeters in specimens taken from the rising main and low-level reservoir, and in one cubic centimeter in a specimen taken from the high-level reservoir. Samples on August 10th examined at the same laboratory showed bacillus coli in one cubic centimeter of water from the rising main in several specimens.

As to the way in which the water may have become infected.—It should first be mentioned that on nine days between July 9th and 31st inclusive four men had worked in the main well repairing the valves of the pump. The well, which is only 110 feet deep, is easy of access by iron ladders and there are wooden stages. No work was done below the water level, the men denied any possible pollution of the water, and there seemed no reason to suspect fæcal or other pollution of the water through their agency. Nevertheless, as one man had suffered from some illness, said to be rheumatism, whilst away in Canada in the autumn of 1910, it was thought well to examine the blood of the four men to see if Widal reaction was present, and also to examine their urine with a view to the exclusion of any possibility of either of the four being a " carrier " of enteric fever. The results of these examinations were negative in all cases. All these men had been employed at the waterworks for some years past. There was no history of suspicious illness in their families. There did not, therefore, seem any possibility that these men could have infected the water of the well.

Just above the point where the waterworks abut on it the London Road bifurcates, one division continuing straight as the Watling Street and the other curving away northwards. In the angle between these two roads are two terraces of houses, 46 in all. These houses are in the Strood Rural District. The town council fearing pollution of their water from cesspools, which would have been constructed for these houses when they were built, arranged with the rural district council that they should be sewered. They are all connected to a sewer which crosses the Watling Street and joins a cesspool in the allotment gardens which belong to the town council. Thence the sewage overflows through a pipe, which is joined by another drain from a farmyard, and runs through the waterworks site, where it is joined by a pipe conveying the overflow from a cesspool on the site receiving sewage from the house occupied by the waterworks manager. The pipe conveying the overflow from these cesspools then passes to the London Road and joins a surface water drain, which after being joined by the pipe conveying the overflow from a cesspool at a public-house at the other side of the road opposite to the waterworks passes down the hill, ultimately joining the river. In one of these houses, the fifth house from the Watling Street of a terrace fronting on the London Road, a case of enteric fever has been nursed from May 2nd to June 20th, 1912. The fæcal matter from the patient is said to have been buried in the garden, but the liquid discharges were thrown down the water-closet with which the house is provided. It was, therefore, clear that enteric fever infection had passed into drains and cesspools in close proximity to the waterworks well, and if any leakage occurred of the contents of these drains or cesspools into fissures in the chalk, such as are undoubtedly present in the vicinity of the well, the specific pollution of the water would be extremely probable. There can be no doubt that the drains cross fissures in the chalk more or less at right angles, and that they must be laid in the chalk, in which also the cesspools are constructed.

Unusually heavy rainfall occurred in the month of June, no less than 1·39 and 1·15 inches falling in the weeks ending on the 8th and 15th of that month. Following this the water level in the adit was unusually high for the time of year in the two last weeks of June and two first weeks of July.* The first case of the outbreak became infected in the week ending June 29th. The combination of circumstances and sequence of events suggest that this heavy rainfall caused infecting material to be washed from drains or cesspools into the water of the adit.

So far the cesspools in the allotment ground and on the waterworks site only have been tested, and were found to be watertight. The drain leading from the invaded house was tested with smoke test only and found faulty. No examination of the sewer passing from these houses under the Watling Street to the cesspools or of the drain leading from the waterworks cesspool under the London Road has yet been made. The latter drain is in a position where it must be liable to damage, since the traffic on the road is very heavy. Trams ascend and descend the hill, and a number of heavy traction engines and motor lorries pass over it daily.

In view of these facts it seems needless to search for further possible sources of pollution of the water, but they should be mentioned as showing the varied risks to which the water furnished by the waterworks is exposed.

A number of cesspools in houses in London Road a short distance to the north of the well were "sludged" by the town councils staff on July 23rd, 1912. New cesspools were also dug for several houses above the level of the waterworks well, and a short distance from it, in the London Road, in April 1912. These cesspools were made in the chalk which was described as being in the form of large masses separated by open joints. These cesspools were required because the old ones were too near the houses, and the drains connected with them were found defective and blocked with fæcal matter. The old cesspools were filled in.

The allotment gardens which are about 200 yards to the west of the well belong to the town council. The gardens are heavily manured; street sweepings, house refuse, and stable manure being used. Each holder has his manure heap, and at the time of my visit many tons of manure were stored there. As far as can be ascertained, privy filth and the contents of cesspools from the rural district are not employed. The ground slopes quickly to a hollow which would roughly overlie the main adit if it is continued as a fissure in that direction, and the appearances are suggestive of the presence of a swallow hole there, but owing to the ground being covered with crops no further examination could be made. If such a swallow hole were present it would not be many feet above the level of the adit and might possibly communicate with it.

---

* *See* Diagram.

Eastward the fissure forming the main adit is running in a direction corresponding with that of Janes Creek which reaches within 600 yards of it. It is not unlikely that this creek indicates the point where the underground watercourse forming the fissure comes to the surface and discharges its water to the river. If this is so it is possible that, at high water at any rate, long continued pumping might in a dry period abstract polluted water from the creek.

(3.) MEASURES TAKEN BY THE TOWN COUNCIL FOR PREVENTING THE SPREAD OF FEVER.

On the occasion of my first visit on August 12th when it seemed clear that the water of the Strood Waterworks was the probable medium of infection, the Medical Officer of Health and the Surveyor had decided that some chemical treatment of the water would be necessary. The disinfection of the mains and reservoirs with a solution of one in 20,000 of "chloros," followed by the continued addition of one part per 100,000 to the water in the low level reservoir through which the whole supply passes previous to its distribution, was decided upon. Owing to various circumstances, particularly the difficulty of emptying the reservoirs, this could not be effected until August 17th, after which date all the water was so treated. Reference to the diagram will show that only five cases became infected after this date.

On August 9th posters were issued and distributed to children at the schools, advising all persons to boil the water before use. The harbour master was asked not to supply shipping with the water, and mineral water manufacturers were also advised not to use it. Arrangements were made with neighbouring authorities to take cases of scarlet fever and diphtheria from the borough into their hospitals, so leaving the borough hospital free for the reception of enteric fever only. Owing to these arrangements nearly all the sufferers were promptly removed to hospital. To this must be attributed the small number of secondary cases in households. The fact also that only three cases occurred in houses served by privies no doubt greatly limited the spread of the fever by secondary infection. Disinfection was carried out on removal or recovery of the patient, and any sanitary defects remedied, as far as was possible in the absence of a system of sewerage.

The treatment of the water by "chloros" has been continued up to the time of writing this report, in spite of complaints of its nauseous taste on the part of some of the inhabitants. On October 22nd the amount added was reduced by half, but this reduction appeared to make no difference in the flavour of the water, and complaints continued to be made.

On August 23rd, six days after the introduction of the treatment by chloros, specimens were taken from the rising main, also from taps drawing from the high and low-level services, and examined in the county laboratory. While the results showed that the bacillus coli was present in two out of five samples of ten cubic centimeters from the rising main, the water from the high-level supply was almost sterile, a few moulds only growing on gelatine, and these were the only organisms present in quantities up to 50 cubic centimeters. The specimens from the low-level supply were also almost sterile, no growth being obtained in similar quantities of water.

Specimens were taken on October 2nd from the rising main and examined at the county laboratory and by Dr. Spitta, in each case bacillus coli was found in 50 cubic centimeters but not in less. On October 22nd, bacillus coli was found to be present in 25 cubic centimeters of water from the rising main at the county council laboratory, and in 50 cubic centimeters by Dr. Spitta. So far as these results go they suggest that there was less pollution of the raw water in the well than was the case in August. The water in the reservoir after treatment was found sterile by both observers. The quantity of chloros had at this time been reduced by half.

On the other hand chemical analysis of water from the rising main taken on October 22nd and made by Dr. Spitta showed total solids 62·4; chlorine, as chlorides, 8·16; free and albumenoid ammonia, ·002 and ·006 respectively; nitrogen, as nitrites and nitrates, ·83; oxygen consumed at 37 degrees centigrade in four hours, ·09 grains per gallon. These results compared with an analysis made by Dr. Spitta in 1906 showed increased quantities of all these components, except of nitrates, and also of the amount of oxygen consumed, thus indicating the deterioration which has taken place in the quality of the water during the last six years. The figures for 1906 were 49·1, 6·8, nil, ·002, ·84, ·03, respectively.

From the foregoing account it will be seen that the water from the Strood Waterworks can no longer be considered safe for use. The sources of possible pollution are so numerous, and are increasing so much with the extension of building operations in the borough and adjoining rural district, that it will be impossible with certainty to exclude them.

With regard to the possibility of such continued chemical treatment of the Strood water as will ensure absolute safety, it cannot be said that there is any chemical which can be systematically used in such quantities as to deal with a sudden and relatively heavy infection of the water, such as might occur under the circumstances to which the waterworks are exposed, without serious disadvantages. Among these may be mentioned the unpleasant taste communicated to the water, interfering with its use for domestic proposes, and also possible injurious influences on the health of consumers, while the possible interference with the use of the water for the purposes of certain trades and manufacturers, such as brewing, dyeing, and the making of mineral waters, has also to be considered. Owing to various causes such treatment may fail of application just when it is most wanted, and it requires constant and vigilant supervision. In the case of chlorine compounds the possible action on pipes, valves, and taps, which is stated already to have given trouble in the case of taps at Strood, has to be borne in mind.

The town council, therefore, will be well advised to seek for a fresh source of water supply for Strood which will not be liable to risk of pollution.

For much assistance in preparing this report, I am indebted to Dr. Pritchett and Mr. William Banks, the Medical Officer of Health and Surveyor for the borough respectively.

S. W. Wheaton.